RE-APPEARANCE OF THE BLUE MUDHOPPER, *SCARTELAOS HISTOPHORUS* (PISCES: GOBIIDAE) IN THE GREATER BRISBANE AREA

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Mudskippers have not been reported in the greater Brisbane area since 1919 (McCulloch & Ogilby, 1919). Recently, large populations of these animals were observed along the banks of the Brisbane River. A survey of the mudskippers in the greater Brisbane area was initiated and only the blue mud hopper, *Scartelaos histophorus* was identified. It has a discontinuous distribution from the mouth of the Brisbane River upstream to the suburb of Fig Tree Pocket and as far south as the suburb of Lota. Preliminary information on seasonal change in abundance for *S. histophorus* was obtained during this study. Future research areas based upon mudskippers as biological indicators are outlined. ☐ *Scartelaos, ecology, distribution.*

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Mudskippers are amphibious gobiids found in the muddy intertidal zones of tropical and subtropical coasts and estuaries. They are distributed from northern Australia to as far north as Kuwait Bay, including the east and west coasts of Africa, Melanesia, Micronesia, India, Polynesia and the West Indies (Stead, 1906; McCulloch & Ogilby, 1919; Marshall, 1966). The members of the Gobiidae that are commonly known as mudskippers are divided into the Periophthalminae and the Apocrypteinae; the former being more territorial. Representatives from both subfamilies have been recorded in Australia (McCulloch & Ogilby, 1919; Weber & DeBeaufort, 1953; Marshall, 1966; Milward, 1974; Grant, 1985).

The first record of mudskippers in the Brisbane area was of *Periophthalmus vulgaris* Eggert, 1935 (given as *P. koelreuteri* (Pallas)) in 1877 (Castelnau, 1878). Since that time no other study, including the comprehensive study conducted by Milward between 1964 and 1974 along the Queensland coast, had noted this species in the greater Brisbane area. Milward (1974) found the southern limit of *P. vulgaris* distribution to be Burnett River Heads (latitude c. 24°45'S).

In 1919 another species (*Scartelaos histophorus* (Cuvier & Valenciennes, 1837)) was noted in Moreton Bay and along the Brisbane River; identified as *S. viridis* by McCulloch and Ogilby (1919). This was the only report of these mudskippers in Australia until 1966 when a survey which included all of the eastern Queensland coast, noted *S. histophorus* to have a distribution no further south than Bundaberg (lat. 24°53'S) (Marshall, 1966). Milward's (1974) study extended the species' range to Urangan (lat. 25°15' S) in Queensland (Milward, 1974). Despite an extensive search for mudskippers in the greater Brisbane area, none were found (N. Milward, pers comm.).

The objectives of this study were two fold, firstly to identify the species of mudskippers found in the greater Brisbane area and secondly to survey the distribution and zonation of these species.

METHODS AND MATERIALS

Surveys of the distribution were carried out by visiting river and bay shores of western Moreton Bay, south east Queensland (27°22'S, 153°10' E). Additional information was obtained through interviews and reports supplied by members of the public, Brisbane Transport and university staff in response to newspaper articles. Written correspondence from the public was followed up by an interview by the principal investigator to confirm the identification of the animals, as often intertidal fish such as the peacock blenny (*Istiblennius meleagris* (Valenciennes)), family Blenniidae, were identified as mudskippers. This interview was then followed up with a visit to the reported location to confirm the distribution report. Through this process the general habitat of the animals was observed and potential sites for mudskipper populations identified.

Walking through the mudflats caused some difficulties as the animals were efficient at detecting movement which caused them to quickly retreat down their burrows. This made positive

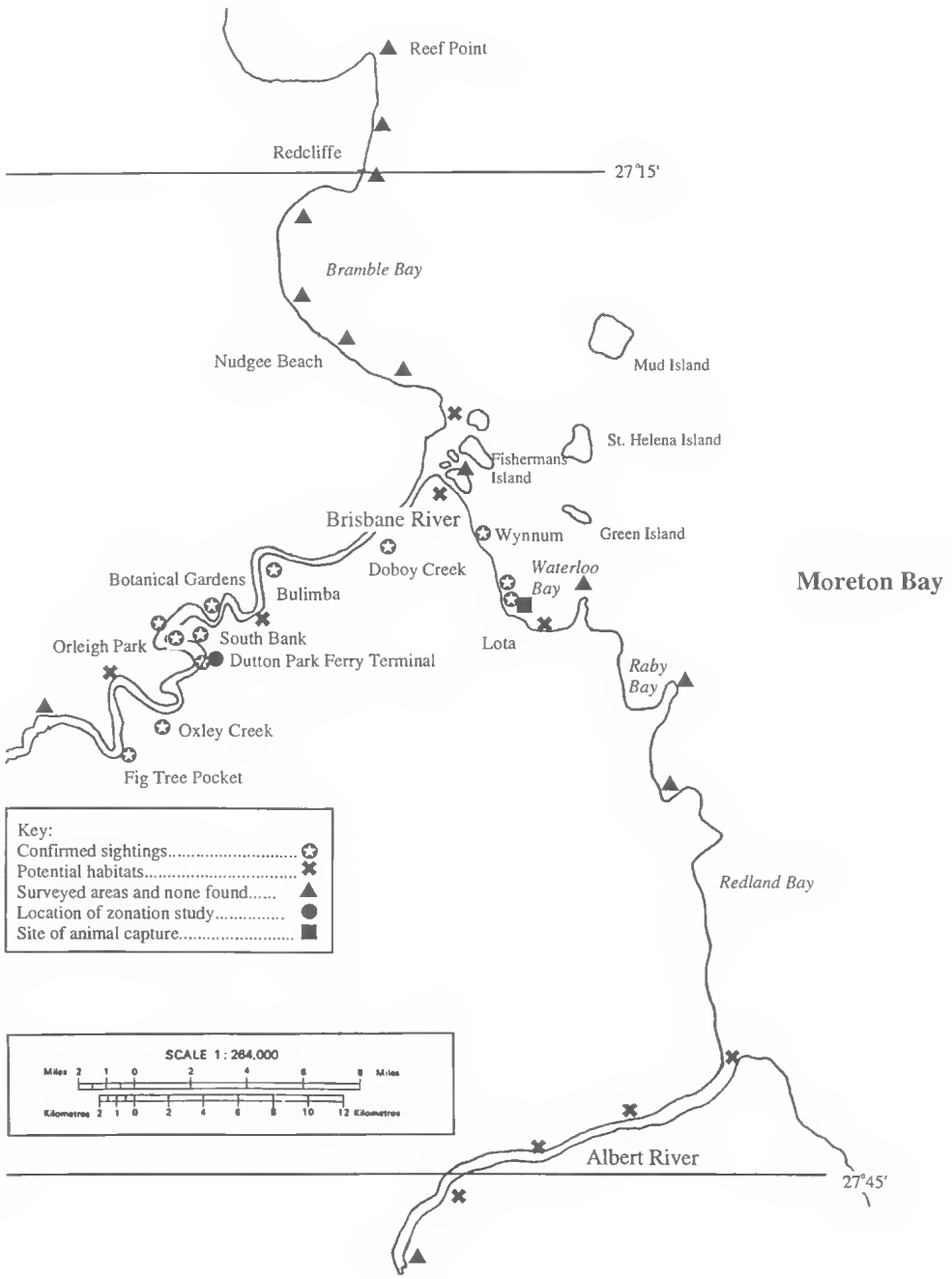

FIG. 1. Study sites and distribution of *Scartelaos histophorus* in the greater Brisbane area.

identification of the animals in the field difficult, specimens therefore had to be secured. The extent of the local distribution may have been under estimated as a result of disturbance to populations caused by the observer before the animals could be detected.

Many methods were employed in the attempts to capture specimens for identification. Past authors have noted this difficulty. D.G. Stead (1906) wrote "the capture of the little fish seems at first to be an easy task, but woe betide the reckless enthusiast who ventures on the treacherous ooze in its vain pursuit. He will emerge from the enterprise with bemired raiment and a much-chastened spirit!". Milward (1974) also tried many methods and was reduced to "patience and guile" to capture the fish, where as Stebbins and Kalk (1961) stunned the creatures using "rubber bands cut from automobile tires and fired from the thumb". For this study, attempts were made using a throw net, a nylon noose, a dip net and by simply attempting to chase and pounce upon them. The method that proved most successful consisted of stalking the animals at night during low tide with the aid of a spot light. Once dazzled the fish were scooped up using a bucket. The animals used for identification in the laboratory were captured by spotlighting in the Lota area.

The identification of the captured animals was done using a taxonomic key prepared by Milward, 1974. An ecological key developed from Milward (1974) and plates from Milward (1974) and Grant (1993) assisted with long range identification.

RESULTS

Spatial distribution: Only one species of mudskipper, *Scartelaos histophorus* (Apocrypteinae), was found in the Brisbane area during this study. Morphological characteristics of captive specimens were in agreement with the description given in the taxonomic key devised by Milward (1974). The body of the animal is elongate with very small scales. The dentition consists of subhorizontal teeth in the lower jaw with caninoid teeth on each side of the symphysis. The second dorsal fin is elongate with 20 rays. The bulbous eyes contain a free lower eyelid and rows of short barbules are found on each side under the lower jaw. The colour of the dorsal surface in life is very similar to the substrate on which they live, with the ventral surface being white. When preserved, the animal takes on a slate blue colour from which the common name blue mud hopper (Grant, 1993) may have arisen.

S. histophorus are found in areas containing substantial amounts of thixotropic mud (with a depth to the compact layer ranging from approximately 0.1-1m deep) and are usually associated with mangrove areas which undergo cyclic tidal emersion. Their distribution extends from the mouth of the Brisbane River, inland to the suburb of Fig Tree Pocket (Fig. 1). Visual searches did not uncover any animals from Nudgee Beach to as far north as Reef Point (Fig. 1). These areas, although containing apparently suitable habitats associated with mangroves, did not support communities of S. histophorus. The tidal flats associated with the suburbs of Lota supports a large colony (c.>1000) with potential distribution extending at least as far south as Waterloo Bay.

Temporal patterns - long term: Interviews were conducted with two employees of the Brisbane Public Transport service who have worked on the Dutton Park - University of Queensland ferry service for many years. They reported that they had not noticed the mudskippers until the summer of 1992. They kindly interviewed their co-workers, many of whom have worked on the Brisbane River for more than ten years, and they too confirmed this observation.

The owner of a local aquarium shop captured some of the animals when she first noted them, again the date reported was 1992. Information solicited from the Brisbane community via articles placed in local newspapers indicates that the mudskippers may have been present as early as the early 1970's in isolated pockets in the Wynnum area (M. Peart, pers. comm.). The areas of Doboy Creek, Dutton Park Ferry terminus, Orleigh Park (J. Thomson, pers. comm.), Oxley Creek (D. Miller, pers. comm.) and the mud flats at Bulimba (R. Ritey, pers. comm.) were also identified as mudhopper habitats.

Temporal patterns - seasonal: Preliminary information on apparent seasonal change in abundance was obtained during this study. Animals were first observed by the authors following the first sighting of *S. histophorus* at Dutton Park Ferry terminus in the summer of 1992-93 and subsequently disappeared in the winter of 1993. They reappeared in October 1993 (late Spring). The number of animals noted during the present study (c.60) reduced sharply in March 1994 (late summer) until their disappearance in May 1994 (early autumn). The numbers of adult animals substantially reduced in numbers from the Dutton Park study site c. April 11-15.

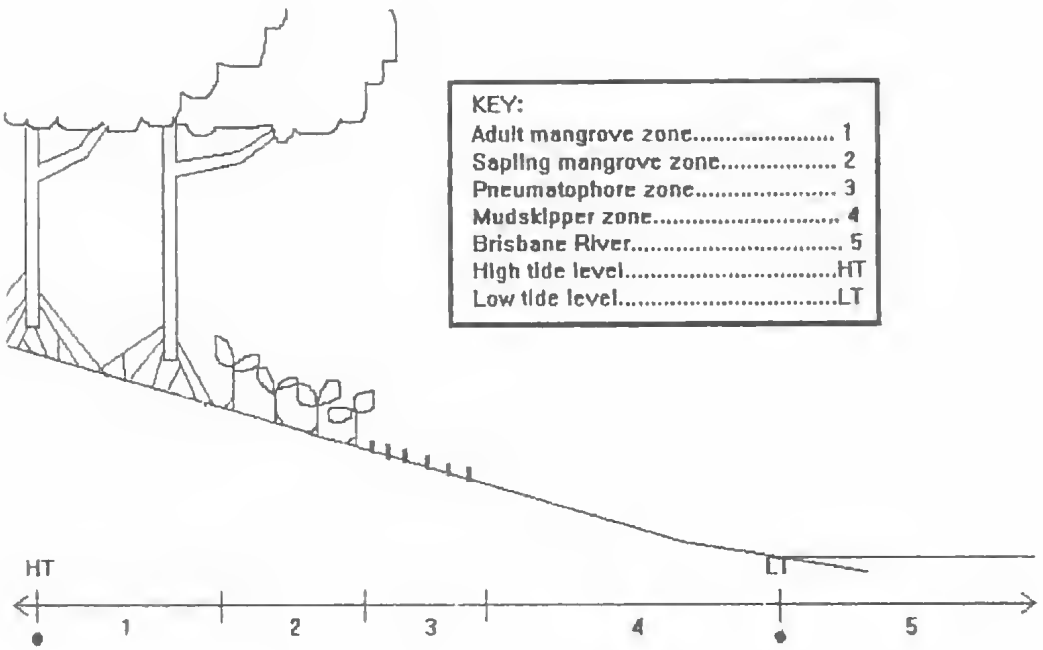

FIG. 2. Zonation pattern present on the shore of the Dutton Park ferry terminal.

At the start of the distribution observations only adult animals were sighted. The first juvenile (c.50mm total length) was recorded from Dutton Park study site on March 4. Juveniles were found in a different zone (the pneumatophore zone) from the adults and were still present at the study site after adult numbers had reduced substantially. By mid August 1994 no mudskippers of any age group were found to be inhabiting the site. All evidence of territories such as holes or shallow pools were no longer present.

Zonation: Animals at the Dutton Park ferry terminus are distributed in a distinct band across the shore. The shore at the Dutton Park Ferry terminus is divisible into four distinct zones (Fig. 2). The first zone consists of adult mangroves (*Avicennia* sp.) which grew close to the high water mark. The second zone adjacent to the first is the mangrove sapling zone which contains many fiddler crabs (*Uca* spp.). The third zone was the mangrove pneumatophore zone which contains small unidentified macrophthalmid crabs. Juvenile mudskippers were also found in this area during the months of April and May. Adult mudskippers are found only in the fourth zone from the edge of the pneumatophores (c. mid-tide level) to the low tide mark. *Scartelaos* only becomes active once the tide level had fallen below the pneumatophore zone. The "*Scartelaos* zone" (i.e. below the pneumatophore zone) was also apparent at the Lota study site. The Lota site also includes a fifth zone below the mudskipper colony to the low tide mark in which no animals are observed and thixotropic mud and seagrass dominates. This fifth zone was not observed at the Dutton Park site.

Patterns occurred in horizontal distribution as the animals were not uniformly distributed within the *Scartelaos* zone at the Dutton Park site. The area closest to the jetty contains several mating pairs with all solitary animals being excluded from the area. The area with many lone animals contained mostly displaying animals with very few pairs apparent and many agonistic interactions (Townsend, unpublished data).

DISCUSSION

This is the first detailed study of mudskippers in the Brisbane region. It reveals that either historical records and some detailed studies are less than accurate or that mudskipper range varies remarkably. *Periophthalmus vulgaris*, which had been previously reported in the greater Brisbane area (Castelnau, 1878) was not found. Interviews with ferry staff and members of the Brisbane community indicates that *S. histophorus* has only recently reappeared in substantial numbers in the greater Brisbane area. Seasonal activity was recorded with a complete absence of the animals from the study site during the winter months of August through to mid October. The only other report of seasonality is for *Boleophthalmus pectinirostris* from Japan (Fukuda, 1994). The greatest activity of the animals occurring during the summer months from April to November and only moving to catch food during warm days of winter (Fukuda, 1994). The extreme seasonality of *S. histophorus* may be unique to the Brisbane area as this complete "disappearance" has not previously been reported.

It is hypothesised that the animals undergo either aestivation or migration away from the sites during the winter months. Berti et al. (1992) demonstrated the "homing" abilities of a *Periophthalmus* sp. from a delta in the Tana River (Kenya) and, although this ability was only tested at a maximum distance of 250m away from the territories, similar abilities would be necessary if migration does occur in *S. histophorus*. Alternatively, mudskippers may avoid extremes in temperatures by retreating into deep water-filled burrows (Tytler & Vaughan, 1983) therefore the animals may be aestivating during the winter months. Further study, via tag and recapture or burrow excavation, needs to be undertaken to test these hypotheses.

Mudskippers may prove to be convenient bio-indicators of estuarine health. Further research to this end may investigate the relationship between the benthic diatom community and the density and abundance of mudskippers. For example, subtle modifications of the benthic diatom community, due to anthropogenic effects, may lead to changes in the abundance and distribution of *S. histophorus*. In Japan, reduction of estuarine health due to polluted rivers has been pinpointed as one of the causes of reduced numbers of *Boleophthalmus pectinirostris* (Fukuda, 1994).

FUTURE RESEARCH

In addition, future research may be aimed at answering the following questions. Have the *S. histophorus* communities "returned" to the greater Brisbane area or were they isolated to pockets of fragmented habitat? Can the population change be attributed to pollution levels, substratum changes, increase in mean temperatures or other physical factors? Research should be aimed at identifying if the factors resulting in the changes of distribution of *S. histophorus* are due to environmental quality such as diatom numbers, sediment changes, chemical changes or due to anthropogenic effects or physical changes such as temperature and climate.

Unique to *S. histophorus* in the greater Brisbane area, is the disappearance during the winter months. Research into the activities of the animals during the cold winter periods may be investigated. Are they aestivating or do they under go migration? Winter searches and tag and recapture methods may be employed to answer this.

Little is known about the factors resulting in the age structure, settlement and recruitment processes of *S. histophorus*. The vulnerability of the population needs to be identified. This paper highlights the need for further study to fully understand the role of *S. histophorus* in the Brisbane estuarine ecosystem.

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